EFFECT OF HIGH INTENSITY INTERVAL TRAINING ON CARDIORESPIRATORY ENDURANCE, ABDOMINAL MUSCLE STRENGTH AND ARM MUSCLE STRENGTH IN INDONESIAN AIR FORCE SOLDIERS AT ADI SOEMARMO AIR FIELD

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Abstract: *Soldiers should always keep their physical condition in good order. Cardiorespiratory endurance, abdominal muscle strength and arm muscle strength are important aspects that support soldier performance. Cardiorespiratory endurance is important to ensure soldiers can work according to the targeted duration. Good abdominal muscle strength supports soldiers to minimize back pain. Soldiers often had to carry heavy loads in backpacks that had to be carried a certain distance and duration. Soldiers are also confirmed to undergo shooting drills. Withstanding the recoil requires good arm muscle strength. Arm muscle strength determines the number of shots that are limited because it relates to how often you hold the recoil. High Intesity Interval Training (HIIT) is conducted so that soldiers get improvements in these three aspects. The training process is carried out within a span of 8 weeks. Based on the results of the paired t-test, it is known that there is an effect of HIIT on the three research variables. This is based on Sig. <0.005 which indicates that Ha is accepted.*

Keywords: Indonesian Air Force, Fitness, HIIT

Table of Contents

1. INTRODUCTION

The implementation of the duties of the Indonesian Air Force is closely related to the physical components of each soldier. Soldiers of the Indonesian Air Force are required to maintain their physical performance in order to remain in prime condition. Excellent physical condition is one of the dimensions of health that can be obtained from a good diet, exercise, avoiding bad habits, practicing safe sex, recognizing symptoms of disease, carrying out regular check-ups and avoiding injury. (Fahey et al., 2019). The design of the surrounding environment influences the individual's physical fitness (Duncan et al., 2021). Soldiers periodically undergo tests and measurements of physical condition. The simple function of physical measurement is to provide an overview of a person's physical condition (Gupta, 2012).

During training and war, soldiers have to carry heavy war equipment plus logistics for life's necessities (Bossi et al., 2020). A fit physical condition is a must for Indonesian Air Force soldiers. Physical fitness in soldiers is something that becomes a character (Mavor et al., 2022). The minimal intensity of movement affects physical fitness and the risk of weight gain (Drenowatz & Greier, 2020; Haugen & Johansen, 2018). The obligation of Indonesian Air Force soldiers to maintain fitness can still be carried out during their busy lives on duty. High standards regarding physical fitness are something that must be a daily part of soldiers (Pierce et al., 2017). The soldier's fitness condition must be at a high level which is the standard so that the soldier remains in ready-to-duty mode (Jayne et al., 2021).

The rapid development of science has made many things simpler and faster, including in practice

(Hemmatinafar et al., 2020a). Fast and effective workouts for losing fat are constantly evolving because of support
from research on HIIT (Hall, 2015). HIIT is a physical activity that is included in the top 10 popular activities to maintain fitness (Kegel et al., 2020). HIIT is a physical activity that doesn't take long to implement. HIIT is usually done through 8 physical activities with a ratio of 20:10 for doing and resting time (Viana et al., 2018). HIIT can also be done with a 30:30 ratio procedure for doing and resting time (Eather et al., 2019). HIIT is proven safe and improves cardiovascular capacity and quality of life (Deka et al., 2021). HIIT can be performed by almost anyone with promising results in terms of increased VO2max and ability to move (Gjellesvik et al., 2021).

The stomach has an important role in protecting the back and is the foundation of strength (Allen et al., 2002). The stomach has an important role in protecting the back and is the foundation of strength (Akuthota et al., 2008). Having well-trained abdominal muscles is a must for a TNI AU soldier. Trained core section can improve strength, balance and reduce the risk of getting injured (Kibler et al., 2006). The physical activity of a soldier is different from ordinary people. A soldier is required to be more physically prepared than ordinary people. On certain occasions Indonesian Air Force soldiers have to move around carrying a backpack weighing 17 kg (Amin, 2014). Good and trained abdominal muscles can reduce the potential for back pain (Peterson et al., 2019). This also applies to soldiers when they are on the battlefield. The distance traveled by Indonesian Air Force soldiers on the battlefield cannot be predicted.

Arm muscle strength affects the potential for injury, fatigue and a person's posture (Nasrulloh & Wicaksono, 2020). The arm is one part of the body that supports humans to move. Many activities performed by soldiers, both daily and in combat situations, involve the use of the arms. The usefulness of the arm can be reduced if you don't have good muscles (Pontonnier & Dumont, 2010). Regular exercise can maintain the quality of arm muscle function, and can even improve it (Franck et al., 2017). One of the special functions of arm muscle strength for soldiers is to carry weapons. An example of a weapon used by Indonesian Air Force soldiers is the SS-1 V2 assault rifle (Subrata, 2019). The weight specification of the SS-1 V2 assault rifle is 3.91 kg without bullets and 4.27 kg with bullets (Pindad, 2019). Conditions when carrying a rifle are not only static but dynamic because on the battlefield a soldier must be able to position himself according to strategic needs. TNI AU soldiers also have to get used to the recoil process. Recoil is the movement of the weapon backwards, towards the shooter, which occurs when firing (Russell, 2013). A soldier's arm muscle strength must be trained in order to increase the limit for opening fire (Burns, 2012).

Cardiorespiratory endurance refers to the ability of the heart and lungs to distribute oxygen for continuous activity and is the main indicator of physical health. (Cheng et al., 2019). Maintaining and increasing cardiorespiratory endurance is an important point in maintaining health (de Carvalho Souza Vieira et al., 2018). As previously discussed, soldiers must be physically prepared under any conditions. As far as possible, soldiers must be physically healthy and free from diseases that interfere with work efficiency. Maintaining cardiorespiratory endurance also means avoiding the body from excessive fatigue (Kiryu et al., 2001). Without the support of strong endurance, it is very likely that soldiers will fail the physical fitness test (Henning et al., 2011). Apart from that, in war simulation conditions, soldiers will be asked to carry heavy loads within a certain time and distance. Heavy loads require good cardiorespiratory endurance in order to survive (Looney et al., 2018). Heavy loads increase metabolic processes, heart-pulmonary and respiratory responses (Pihlainen et al., 2014; Potter et al., 2017).

Table 1. Centre the Caption above the Table

Variables		N	Mean
	1.	47	30.3
Group	2.	60	38.7
	3.	48	31.0
Age	18-21	150	96.8

	other	5	3.2
Gender	F	117	75.5
	M	38	24.5
Total		155	100

Please embed tables and figures in appropriate areas within the document and center them horizontally. Tables and figures should not exceed the given page margins. Provide captions (maximum length: 6 to 8 words) for each table or figure. Centre the caption above the table and below the figure. Please reference the table or figure in the text (see Table 1). Please do not use vertical lines in tables. For figures, GIF and JPEG (JPG) are the preferred formats.

2. METHOD

Second Level Headings

The research was carried out at the Adi Soemarmo Air Field Complex. The population in this study were Indonesian Air Force Soldiers at the Adi Soemarmo Airfield. Sampling requires the right sampling technique in order to get the appropriate sample. Sampling is an important tool for research because the population under study is usually too large to include as research participants (Majid, 2018). The sampling technique used is Random Sampling. Random sampling is a sampling technique with high probability because it is chosen randomly (Etikan, 2016). A total of 30 soldiers were involved in the study with details of 15 as the experimental group and 15 as the control group.

Data collection was carried out during the pretest and posttest. The instrument used is a rank promotion instrument that is often used by Indonesian Air Force Soldiers. The data used as an indicator of the course of the research process is physical fitness data. Retrieval of physical fitness data uses the samapta test item used by the Indonesian Air Force in selecting prospective soldiers. This instrument has often been used by the Indonesian Air Force so that its validity and reliability have been tested. Another advantage of the TNI AU's instruments is that the research samples and field assistants are familiar so that the quality of the data collection process is maintained. The treatment that the experimental group underwent was HIIT. The HIIT used is HIIT with the easiest to the most difficult levels (Rey, 2019). The control group continued to carry out the regular exercise activities that had been carried out previously.

Table 1. HIIT Workout Program

Week	Difficulty Level (Scale 5)	Program*
First	Scale 2	15 seconds march steps 15 seconds high knees 15 seconds arm circles 15 seconds high knees 15 seconds bicep extensions 15 seconds high knees
Second	Scale 2	20 seconds jumping jacks 10 seconds side leg raises 20 seconds high knees 10 seconds climbers
Third	Scale 2	30 seconds half jacks 10 seconds jumping lunges 30 seconds half jacks 30 seconds march steps 10 seconds high knees 30 seconds march steps 10 seconds calf raises 10 seconds jump squats

Week	Difficulty Level (Scale 5)	Program*
		10 seconds calf raises
Forth	Scale 3	20 seconds high knees 20 seconds elbow plank 10 seconds basic burpees (3 times)
Fifth	Scale 3	15 seconds squat hops 15 seconds bounce+squat 15 seconds high knees 15 seconds shoulder taps 15 seconds punches 15 seconds high knees 15 seconds climbers 15 seconds sprinter lunges 15 seconds high knees
Sixth	Scale 4	20 seconds jumping jacks 20 seconds burpees 20 seconds jumping jacks 20 seconds wide plank hold 20 seconds jumping jacks 20 seconds wide plank hold 20 seconds jumping jacks 20 seconds burpees 20 seconds jumping jacks
Seventh	Scale 4	15 seconds jumping jacks 15 seconds push-ups 15 seconds basic burpees 15 seconds jumping jacks 15 seconds punches 15 seconds basic burpees 15 seconds jumping jacks 15 seconds push-up 15 seconds basic burpees
Eighth	Scale 4	20 seconds jumping jacks 20 seconds lunges 20 seconds jumping lunges 20 seconds jumping jacks 20 seconds plank 20 seconds raised leg plank 20 seconds jumping jacks 20 seconds squats 20 seconds jump squats

*2 minutes rest between sets

The instruments used were 1 minute sit ups, 1 minute pull ups and the Cooper test. Sit up 1 minute is a test item to measure the strength of the abdominal muscles that is suitable and easy to implement. Sit up 1 minute is the test item that is least affected by the anthropometry of the test object (Kukić et al., 2022). The pull up test is an upper extremity measurement test item that has high reliability and an error rate below 3%. (Coyne et al., 2015). The Cooper test has high reliability in measuring the testee's endurance (Alvero-Cruz et al., 2017). Cooper test is a test conducted to measure VO2max by running as far as possible for 12 minutes (Alvarez-Ramirez & Rodriguez, 2021).

VO2max is an indicator that determines aerobic capacity or cardiorespiratory endurance (Coquart et al., 2014; Midgley et al., 2007).

The normality test was carried out on the results of the pre-test and post-test. The normality test uses the Kolmogorov Smirnov test and the homogeneity test uses the Levene Statistics. This test tends to be used to detect that a sample comes from a population that is normally distributed or not, it is important to avoid errors in finding information on the sample being tested so that you are not mistaken in making decisions (Artaya, 2019). Hypothesis testing was carried out using a paired t-test. Hypothesis testing is a statistical test applied to a data set to define and measure the relationship between the variables under consideration (Kumari & Yadav, 2018).

3. RESULTS

The pre-test was carried out using the Indonesian Air Force's physical fitness measurement test items. The test items were chosen because the research sample was familiar with the test items. Experience determines the success of the implementation of the test because the testee's understanding affects the test results (Septianus et al., 2019). The pre-test results can be seen in table 2.

Table 2. Pre-test results

No.	Respondents	12 Minutes Running	Pull Up	Sit Up	Group
1	R1	2320	10	42	Control
2	R2	2100	6	32	Control
3	R3	2420	15	43	Control
4	R4	2450	12	40	Control
5	R5	2210	4	30	Control
6	R6	2250	6	35	Control
7	R7	2210	12	42	Control
8	R8	2300	9	38	Control
9	R9	2300	5	34	Control
10	R10	2430	10	40	Control
11	R11	2215	5	36	Control
12	R12	2100	5	33	Control
13	R13	2210	7	38	Control
14	R14	2510	6	32	Control
15	R15	1875	4	30	Control
16	R16	2445	13	39	Experiment
17	R17	2560	10	43	Experiment
18	R18	2100	10	31	Experiment
19	R19	2410	10	40	Experiment
20	R20	1960	10	40	Experiment
21	R21	2030	6	37	Experiment
22	R22	2310	6	35	Experiment
23	R23	2150	6	30	Experiment
24	R24	2480	5	35	Experiment
25	R25	1705	5	29	Experiment
26	R26	2445	9	43	Experiment
27	R27	2180	7	37	Experiment
28	R28	2100	5	30	Experiment
29	R29	2365	7	30	Experiment
30	R30	2030	8	25	Experiment

The post-test was carried out after the research sample underwent an exercise program. Details of the post-test results can be seen in table 3. The results can be seen that the experimental group (sample number 16-30) has increased. Based on the raw data, the group that underwent the HIIT program benefited more than the control group.

Table 3. Research Sample Post-test Results

No.	Respondents	12 Minutes Running	Pull Up	Sit Up	Group
1	R1	1900	10	40	Control
2	R2	2100	8	32	Control
3	R3	2400	12	42	Control
4	R4	2300	13	37	Control
5	R5	1600	6	33	Control
6	R6	2000	8	30	Control
7	R7	2200	13	39	Control
8	R8	2100	6	44	Control
9	R9	1850	5	31	Control
10	R10	1900	7	37	Control
11	R11	2075	7	36	Control
12	R12	1210	2	30	Control
13	R13	2135	7	37	Control
14	R14	2100	9	33	Control
15	R15	1900	5	32	Control
16	R16	2780	15	44	Experiment
17	R17	2610	13	44	Experiment
18	R18	2400	12	39	Experiment
19	R19	2600	11	45	Experiment
20	R20	2370	12	43	Experiment
21	R21	2100	9	40	Experiment
22	R22	2625	8	35	Experiment
23	R23	2260	9	40	Experiment
24	R24	2650	7	37	Experiment
25	R25	1950	6	35	Experiment
26	R26	2700	10	45	Experiment
27	R27	2230	9	40	Experiment
28	R28	2320	7	38	Experiment
29	R29	2465	8	39	Experiment
30	R30	2235	10	30	Experiment

The normality test was carried out by the researcher to ascertain whether the data could be processed using a paired t-test. Homogeneity test was also carried out but it is not the main requirement because the paired t-test does not require data homogeneity. Based on the normality test, the data obtained by the researcher is normal. In table 4 it can be seen that Sig. on all data > 0.05. This shows that the data is normal.

Table 4. Normality Test Results

Fitness Type (Based on Test)		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
12 minutes running Pre-test	Control Group	0,179	15	.200*	0,947	15	0,472

Fitness Type (Based on Test)		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
	Experiment Group	0,132	15	.200*	0,949	15	0,514
Pull Up Pre-test	Control Group	0,229	15	0,034	0,892	15	0,071
	Experiment Group	0,171	15	.200*	0,902	15	0,102
Sit Up Pre-test	Control Group	0,128	15	.200*	0,933	15	0,307
	Experiment Group	0,161	15	.200*	0,942	15	0,414
12 minutes running Post-test	Control Group	0,188	15	0,162	0,892	15	0,073
	Experiment Group	0,174	15	.200*	0,961	15	0,717
Pull Up Post-test	Control Group	0,150	15	.200*	0,948	15	0,496
	Experiment Group	0,149	15	.200*	0,964	15	0,762
Sit Up Post-test	Control Group	0,184	15	0,183	0,935	15	0,325
	Experiment Group	0,129	15	.200*	0,935	15	0,324

The homogeneity test is still carried out by researchers to find out whether the sample represents the population or not. The results of the data homogeneity test showed that they were homogeneous. Based on Sig. based on the mean of all data > 0.05. This shows that the data is homogeneous and the sample represents the population studied.

Table 5. Hasil Uji Homogenitas

		Levene Statistic	df1	df2	Sig.
12 minutes running Pre-test	Based on Mean	3,609	1	28	0,068
	Based on Median	3,076	1	28	0,090
	Based on Median and with adjusted df	3,076	1	26,762	0,091
	Based on trimmed mean	3,657	1	28	0,066
Pull Up Pre-test	Based on Mean	2,578	1	28	0,120
	Based on Median	0,711	1	28	0,406
	Based on Median and with adjusted df	0,711	1	22,172	0,408
	Based on trimmed mean	2,203	1	28	0,149
Sit Up Pre-test	Based on Mean	0,783	1	28	0,384
	Based on Median	0,772	1	28	0,387
	Based on Median and with adjusted df	0,772	1	25,927	0,388

		Levene Statistic	df1	df2	Sig.
	Based on trimmed mean	0,756	1	28	0,392
12 minutes running Post-test	Based on Mean	0,015	1	28	0,902
	Based on Median	0,000	1	28	0,992
	Based on Median and with adjusted df	0,000	1	22,079	0,992
	Based on trimmed mean	0,004	1	28	0,953
Pull Up Post-test	Based on Mean	0,450	1	28	0,508
	Based on Median	0,322	1	28	0,575
	Based on Median and with adjusted df	0,322	1	26,313	0,575
	Based on trimmed mean	0,467	1	28	0,500
Sit Up Post-test	Based on Mean	0,284	1	28	0,598
	Based on Median	0,260	1	28	0,614
	Based on Median and with adjusted df	0,260	1	27,254	0,614
	Based on trimmed mean	0,314	1	28	0,580

Through paired t-test it can be seen the effect of treatment in each group. In table 6 it can be seen that the HIIT training program has an influence on results; 12 minutes running, pull ups, and sit ups. This is based on Sig. <0.005 which indicates that Ho is rejected and Ha is accepted. The ha of this study is that there is an effect of HIIT on cardiorespiratory endurance, abdominal muscle strength and arm muscle strength. Another interpretation that can be taken from the paired t-test is that there is a significant increase in each test item in the experimental group. Paired t-test in the control group showed that there was no effect of the exercise on cardiorespiratory endurance, abdominal muscle strength and arm muscle strength.

Table 6. Paired t-test Results

Group	Pair		Paired Differences					t	df	Sig. (2-tailed)
			Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
						Lower	Upper			
Experiment	Pair 1	Pre-test and Post-test 12 minutes running	-201,667	110,836	28,618	-263,045	-140,288	-7,047	14	0,000
	Pair 2	Pre-test and Post-test Pull Up	-1,933	0,704	0,182	-2,323	-1,544	-10,640	14	0,000
	Pair 3	Pre-test and Post-test Sit Up	-4,667	3,039	0,785	-6,350	-2,983	-5,946	14	0,000
Control	Pair 1	Pre-test and	275,333	268,105	69,224	126,862	423,805	3,977	14	0,001

		Post-test 12 minutes running								
	Pair 2	Pre-test and Post-test Pull Up	-0,133	2,134	0,551	-1,315	1,048	-0,242	14	0,812
	Pair 3	Pre-test and Post-test Sit Up	0,800	2,883	0,745	-0,797	2,397	1,075	14	0,301

4. DISCUSSION

Fast and effective workouts for physical fitness are constantly evolving due to support from research on High Intensity Interval Training (HIIT) (Hall, 2015). HIIT is a time efficient exercise as an alternative to aerobic exercise (Paulino da Silva Bento et al., 2021). The results of the post-test show that there is literally an increase in the results of the 12 minutes run, pull ups and sit ups. The results of the paired t-test showed that the experimental group got a significant increase. The hypothesis that HIIT has a positive effect on cardiorespiratory endurance, arm muscle strength and abdominal muscle strength has been statistically proven.

This increase is supported by the ease of doing HIIT. The convenience offered by HIIT is also supported by aspects of safety and affordability. Security is something that needs attention because it relates to a person's physique. Exercise that is unsafe and has not been proven to be performed by almost anyone has the potential to cause malfunction and/or injury. Besides notice sophistication tool as supporters learning and practice, necessary noticed some to matter among them media safety and convenience (Ritonga et al., 2022). Appropriate model development will give contribution to development and achievement (Priyambada et al., 2022). HIIT is proven safe and improves cardiovascular capacity and quality of life (Deka et al., 2021). The HIIT program trains the sample's body on certain parts in an intense and scheduled manner, so it doesn't focus on just one part of the body. Besides that, the duration of activities when doing HIIT is more calculated because it uses an organized rest and recovery system.

The time it takes to get the results is 8 weeks (Volkmar, 2017). HIIT is an effective and easy-to-do method for improving body composition and physical fitness (Wu et al., 2021). HIIT can be done in a ratio of 30 seconds doing with 2-6 minutes of rest and increasing repetitions periodically (starting from 5 reps) each week (Hemmatinafar et al., 2020b; Mendelson et al., 2022). The simulation can be used as a consideration in compiling a training program. For someone with normal conditions who have never done HIIT, it is necessary to build initial fitness conditions (Roy, 2013).

5. CONCLUSION

The rapid development of science has made many things simpler and faster, including in practice (Hemmatinafar et al., 2020a). This simple and quick exercise is one that many people are looking for. The ease of doing exercises allows people to do exercises almost anywhere and anytime. The convenience in question is the involvement of the tool and the time period used in the exercise. HIIT can be performed by almost anyone with promising results in terms of increased VO2max and ability to move (Gjellesvik et al., 2021).

6. ACKNOWLEDGEMENTS OR NOTES

Please collate acknowledgements or notes in a separate section at the end of the article before the references.

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